

The Inevitable Game Changing Consequences of Transforming to an Electric Army

Presented by

Dr. Harry Fair, Director

Institute for Advanced Technology

University of Texas

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The Transformation to Electric Energy is Inevitable - the Operational, Organizational, Industrial and Cultural Consequences Will Be Huge!!!

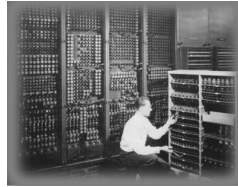
- **Electric Weapons (Railguns and Directed Energy) and electric Protection**
- **Vehicle propulsion**
- **Autonomous Electric Bridge**

These are Disruptive Technologies and have substantial resistance to their development and deployment



Our Ability to Forecast and Maintain the Lead in Future Revolutionary Technology Advances is Fragile

Computing



Big Computer



PC



iPod



Communications



Crank up phones



Push button



iPhone



2008: The number of personal computers in use worldwide hit one billion

“There is no reason anyone would want a computer in their home.”

Ken Olsen, president, chairman and founder of Digital Equipment Corp. (DEC), maker of big business mainframe, arguing against the PC in 1977.

We Also Nearly Missed the Transformation from Propeller to Jet Aircraft

Prior to WWII, NACA study concluded “there was no prospect whatsoever” that jet propulsion will ever be of value, even for military purposes.

US focused on squeezing more and more horsepower out of piston engines

U.S. “stunned” by UK lead in 1941 when Gen. “Hap” Arnold visited UK and witnessed progress; he correctly assumed Germans were also far ahead of the U.S.

Gen. Arnold initiated U.S. effort

- obtained UK permission to build Whittle (UK) engine U.S.
- Excluded all major conventional engine manufacturers
- Selected General Motors to build jet engines

Independent Advocates

- Jack Northrup: built flying wing
- Kelly Johnson: created “skunk works”
developed P-80 “shooting star”



***All highly classified programs to by-pass
“naysayers” - selected individuals only briefed
into programs***



Grand Challenge for the Army: Transition to Electric Energy

“Electric gun technology is a disruptive technology that will require top leadership support and commitment to survive” - - ADM. M. Mullin.

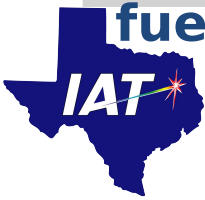
Can electromagnetic weapons eliminate the need for energetic materials (propellants and explosives) on the battlefield

What are the operational, organization, and other consequences?

Can Power, Energy, and other disruptive technologies provide “unlimited electric power” on the battlefield?

Can these be exploited to produce fuel and water on site?

What are the consequences of essentially eliminating fuel, water, and ammunition from the resupply chain?



What Have Been the EMG Critical Challenges, Beliefs and Myths?

- **Lethality**

“No utility in higher velocity”

Uncertainty of 120 mm capability?

Is impact velocity for indirect fire sufficiently high to negate need for explosive warheads?

- **Railgun Launcher**

“Rail life limited to single shot due to hypervelocity gouging”

- **Range**

“We can’t identify targets at long ranges so we don’t need longer range weapons”

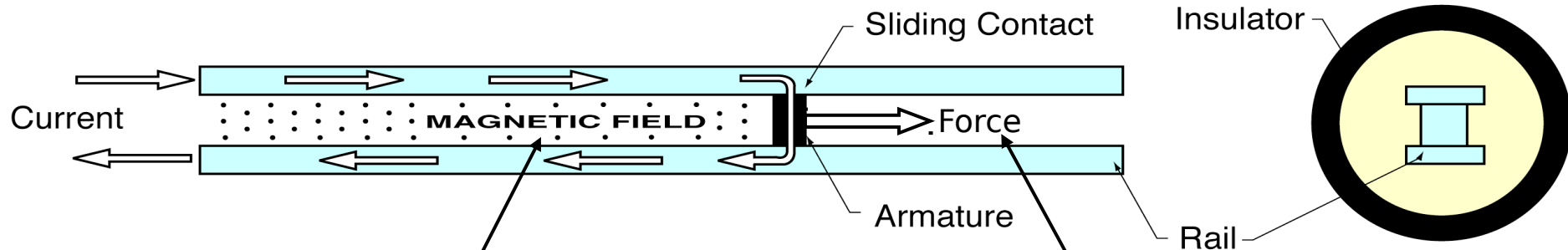
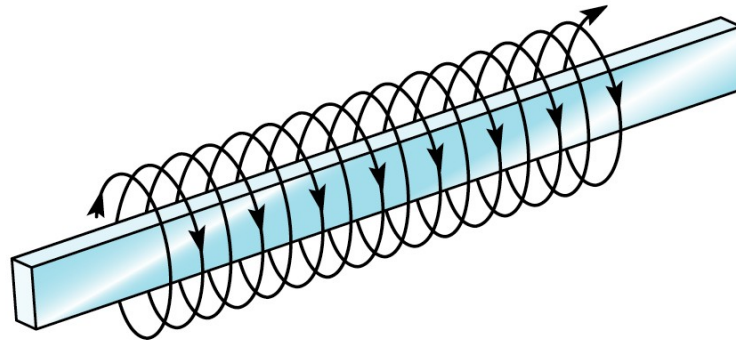
- **Power**

“Power supply too big and heavy - needs 3-story building and there is no commercial interest”



The Physics is Simple- Electromagnetic Railguns convert Electric to Kinetic Energy

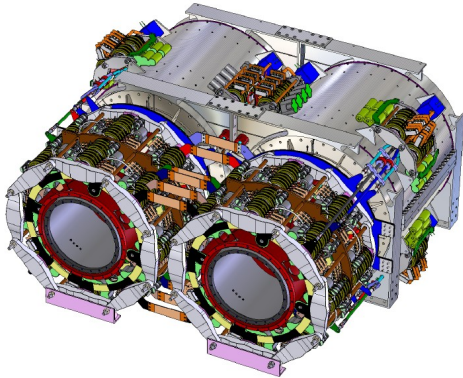
**An electric current
in a conductor
creates a magnetic
field around the
conductor.**



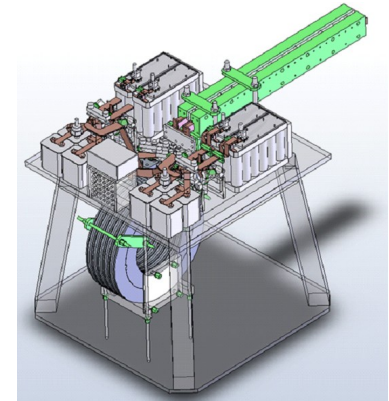
**A magnetic field fills the
region between two
parallel rails**

**The interactions of the
magnetic field and the
current in the conductor
creates an electromagnetic
force** $F = \text{Current}$
 $\text{times magnetic field}$

There have been significant advances in pulsed power technologies



Curtiss-Wright pulsed alternator



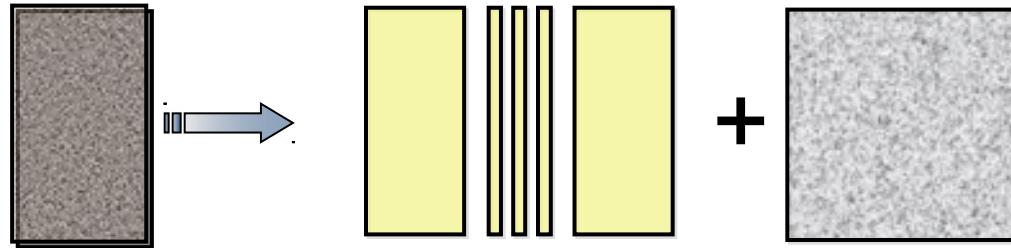
Lithium ion battery / inductor

- **Pair of counter-rotating pulsed alternators under construction**
- **Advanced composite fiber rotors store energy for several shots**

- **Commercial** Lithium battery / inductor system developed by IAT
- **Repetitive high current opening switch invented**

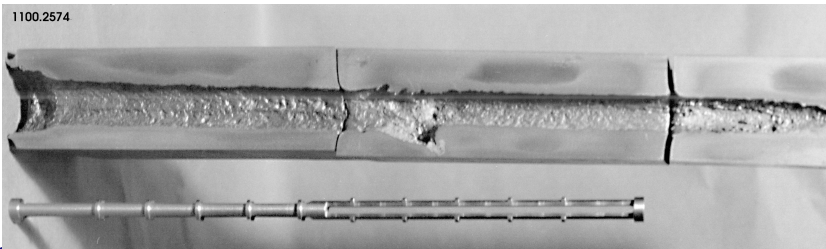
tored energies of 200MJ and kinetic energies of **about 10 MJ at Hypervelocity may be required for direct fire overmatch**

Hypervelocity kinetic energy penetrators launched from Railguns are capable of defeating even the most advanced armor



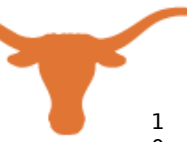
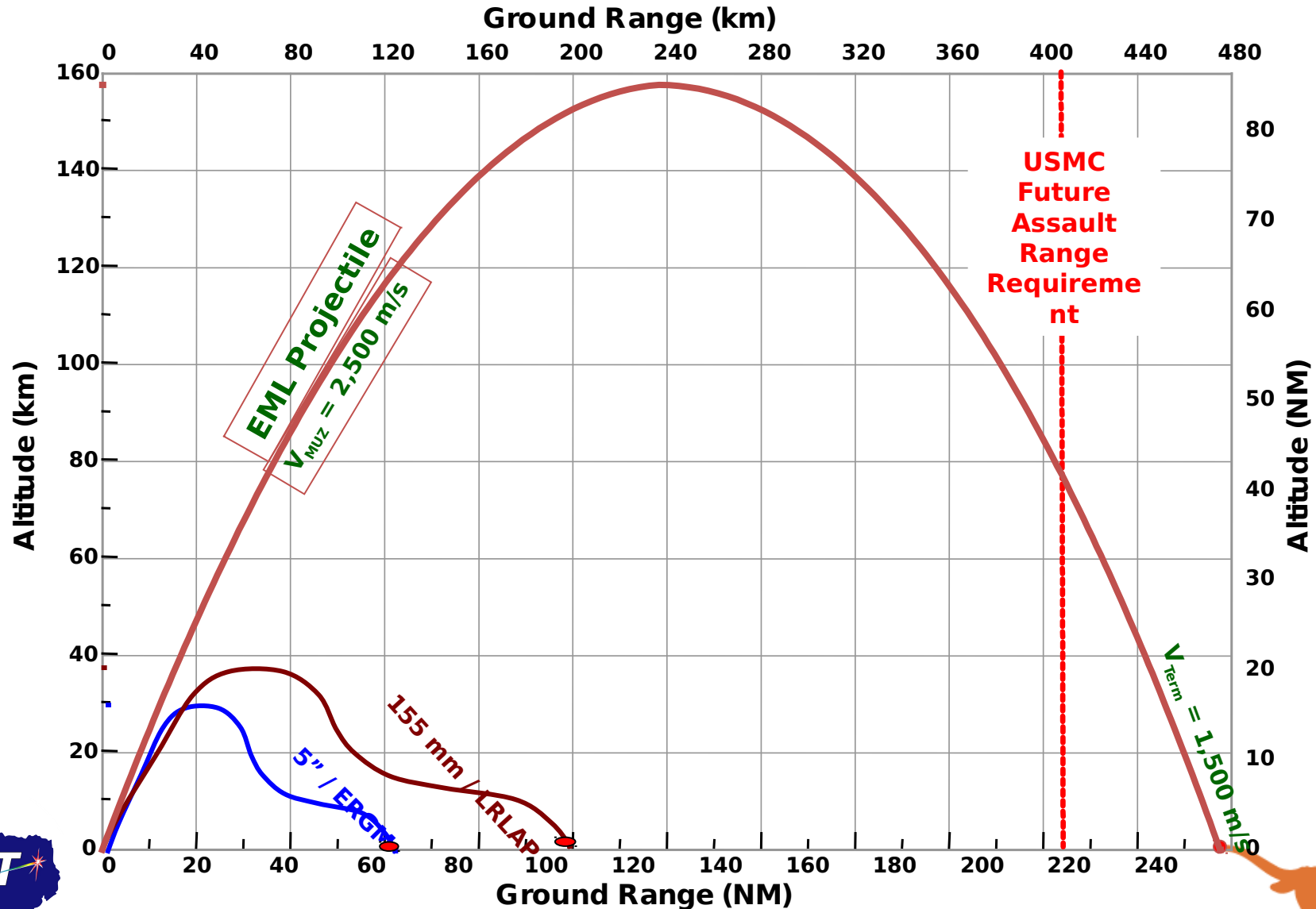
Armor Steel Spaced Base Armor Explosive Reactive Armor (ERA)

- **First-generation explosive reactive armor (ERA) defeats shaped charge warheads- TOW, 120 mm HEAT, etc.**
- **Second and Third-generation ERA has thicker steel plates and defeats conventional kinetic energy rods**
- **Novel hypervelocity kinetic energy penetrators provide robust overmatch**

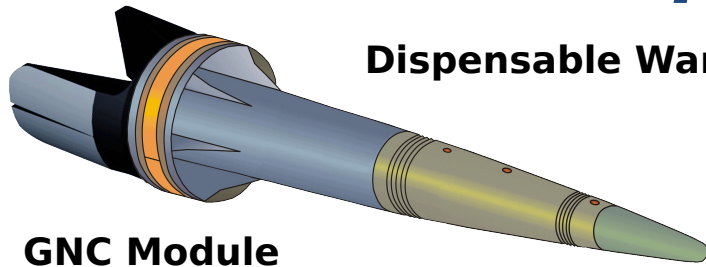


Hypervelocity rods **penetrate** more because **target strength is overwhelmed**

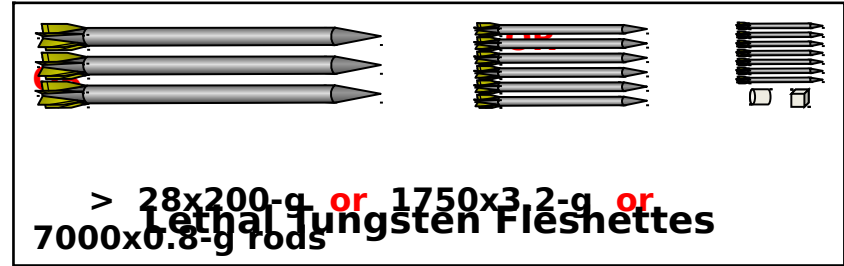
Electromagnetic Railguns also Provide Unprecedented Gun Ranges



Hypervelocity at Impact Enables New Types of Non-Explosive Projectiles

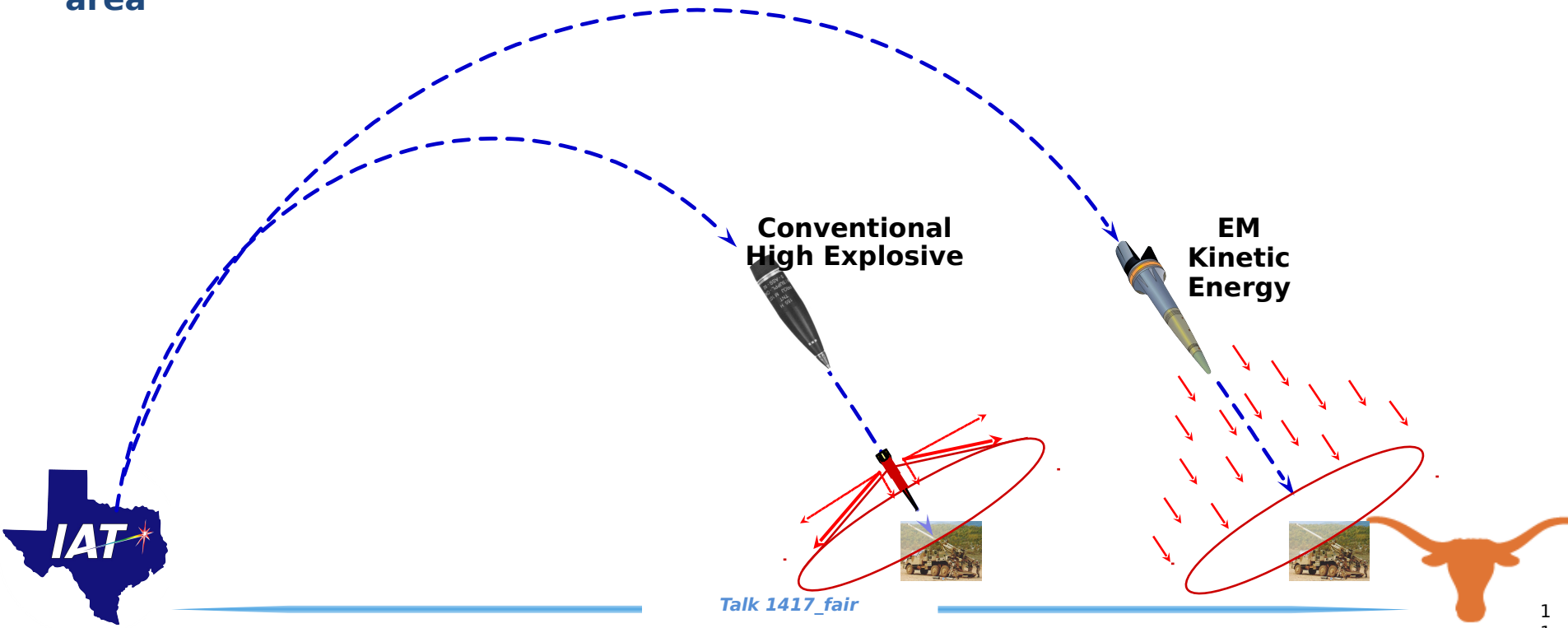


Dispensable Warhead



- Inert tungsten subprojectiles
- Uniform lethality over impact area

- Control impact area by height of dispersal
- Minimum collateral damage



Long Range Precision Fires Over Entire Brigade Battlespace



105 mm 15 km conventional
Artillery battlespace

155mm 30 km conventional
Artillery battlespace

100-500 km Electric
Railgun Battlespace

- Railgun projectile has 2-5 m CEP
- No explosives or propellants
- Low cost GNC



Survivability and Logistics impacts : Elimination of Propellants and possibly Explosives

Precision Direct Fire

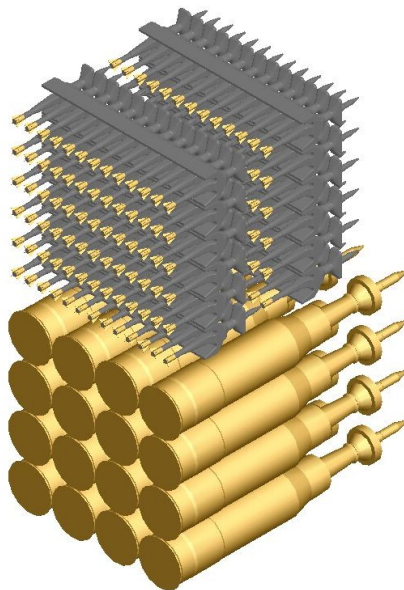


vs



90-mm EM
Round-greater
lethality

150 Inert EM
KE Projectiles
packaged in
same space
as 16 M829s



8% the
Volume
10% the

Precision In-Direct Fire



+



M 107
155mm

vs

No
Propellants

Kinetic Energy Railgun
Projectile

Eliminate/Reduce:

- Propellants and propellant charges
- Army propellant manufacturing facilities
- Army loading facilities
- Army propellant lifetime assessment
- Shipping and storage of hazardous materials

Reduction of:

- Trucks
- Truck drivers } convert to warfighters



Grand Challenges (and Opportunities) for the Army: Transition to Electric Energy

Can electromagnetic weapons eliminate the need for energetic materials (**propellants and explosives**) on the battlefield?

The operational, organizational, and cultural consequences will be substantial

Can Power, Energy and other disruptive technologies provide “**unlimited electric power**” on the battlefield?

Can these be exploited to produce **fuel and water on site**?

What are the consequences of essentially eliminating **fuel, water and ammunition** from the resupply chain?



operation?

The main logistic requirements are *fuel, water and ammunition*



Assume requirement:

Fuel - 30,000 gal/day

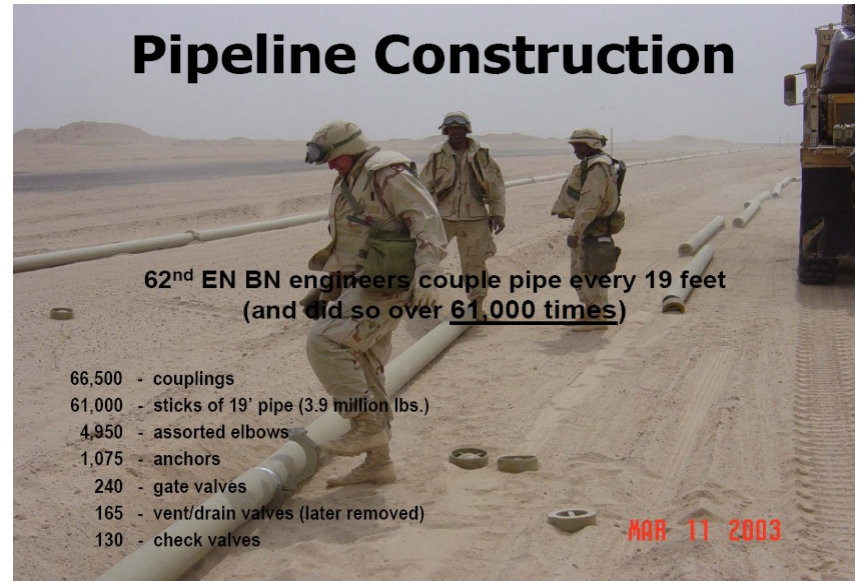
Water - 30,000 gal/day

Class V - 120 tons/day

Vulnerable chain of fuel truck convoys and pipelines supply electric generators and fuel, water and ammunition

Military personnel/equipment diverted for drivers, guards for convoys

This is one of most vulnerable military operations in any theater of operations



Is it possible to make *diesel fuel and water* on site?



Could we really make our own fuel and water on site?



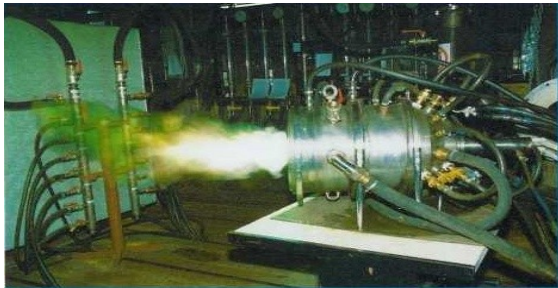
Fischer-Tropsch Reactors

Production of **SYNGAS-Fischer Tropsch**

Germany powered its war machine with **synthetic fuels** derived from coal during WW II.

Commercial **synfuel** plant in South Africa produces 100,000 barrels/day

These are large industrial plants!!!!



Syngas production from waste using plasma torch

Production of **SYNGAS** from **WASTE**

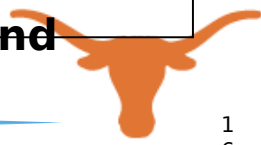
Electric Arc in a plasma generator creates an intense high temperature plasma (up to 20,000 degrees)

Plasma energy breaks molecular bonds of solid, liquid and gaseous compounds- forms atoms and ions

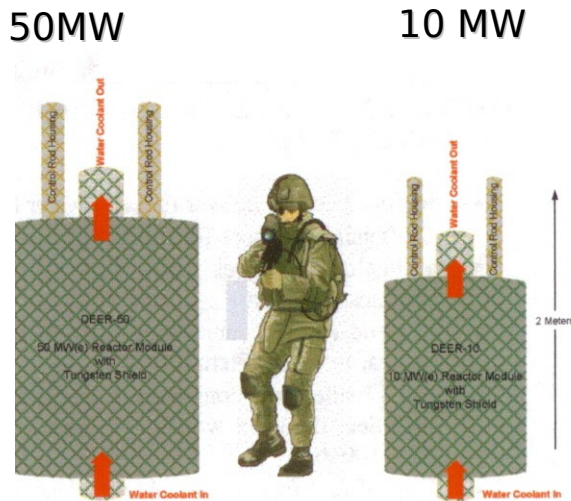
Can advanced technology reduce size of these processes for mobile operations can be reformed into useful products- AND - Where do we get the energy to run them?

Synthetic Gas (**SYNGAS**), **water** and metals

Talk 1417_fair



One way is a Compact Nuclear Reactor



Size of nuclear energy generator

A TRIGA reactor is based upon low ($< 20\%$) enrichment fuel - not useful for diversion to create nuclear weapon.

TRIGA reactors are in use at Universities and hospitals worldwide - none currently protected by combat brigade.

Reactor module operates as sealed unit, complete with fuel. Transported by air or truck trailer.

System may be rapidly deployed to forward operating bases to produce energy and water.

Reactor design and fuel selection will address security, safety and other field operating requirements

Large nuclear power reactors are normally gigantic in large permanent



Compact Nuclear Electric Power-Status and Market

TRIGA Design Philosophy:

- ❖ ***Passively safe design -***
 - ▶ ***Graduate student (and soldier) proof***
- ❖ ***Easy to operate and maintain***
 - ▶ ***automated operation***
- ❖ ***SEALED UNIT***
 - ▶ ***operates autonomously for 2 years***
- ❖ ***Totally self-contained***
 - ▶ ***deployed and installed or removed from field in days***
- ❖ ***Fuel can NOT be used for nuclear weapons***

Technology Status:

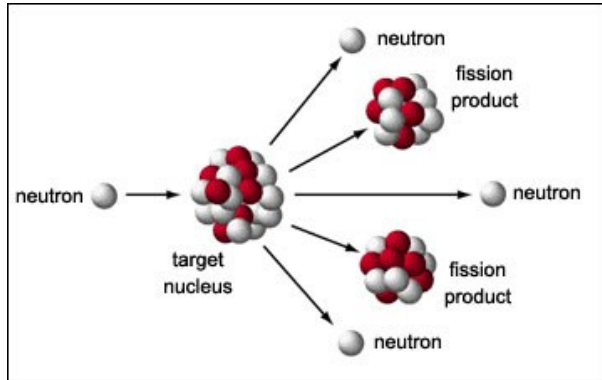
- ❖ ***Mature reactor technologies available***
 - ▶ ***50+ yrs of industry experience***
 - ▶ ***Diverse experience with mobile military reactors (1960s)***
- ❖ ***Advanced reactor concepts being developed by DOE and worldwide consortium***
- ❖ ***Pilot could be built within ~ 4 yrs***

Related Domestic Opportunity:

- **Defense Science Board study highlights vulnerability of US power grid- suggest using compact nuclear reactors at Military bases**

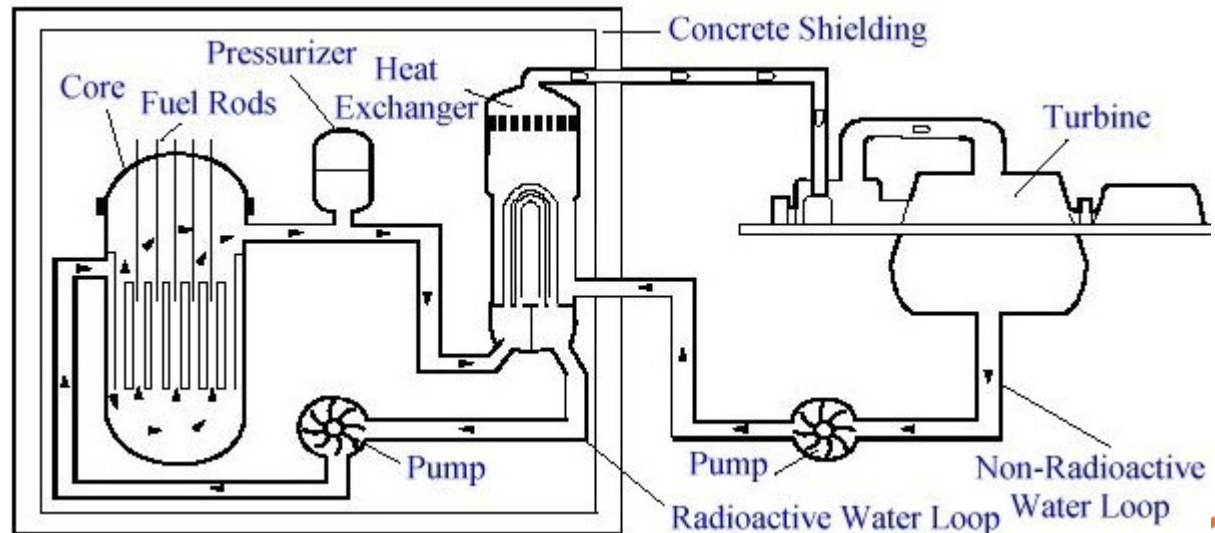


Nuclear reactor can provide “unlimited” supply of ene



Energy density of nuclear fuel about 100,000 times greater than fossil fuel.

- **50+ years of safe operating experience**
- **Nuclear energy supplies 80% of electricity in France; 20% in US; 15% worldwide**
- **Army operated 8 power reactors in 1960s-70s, including C-130 transportable ML-1**
- **Navy operates 103 transportable reactors worldwide**
- **TRIGA fuel enrichment <20% cannot be**



Mobile Nuclear Power

Beliefs and Current Status

Why we “can’t” go nuclear

- Public opinion
- Proliferation concerns
- Investment challenges
- Safety concerns
- Complex operation
- Environmental concerns
- Treaties & politics



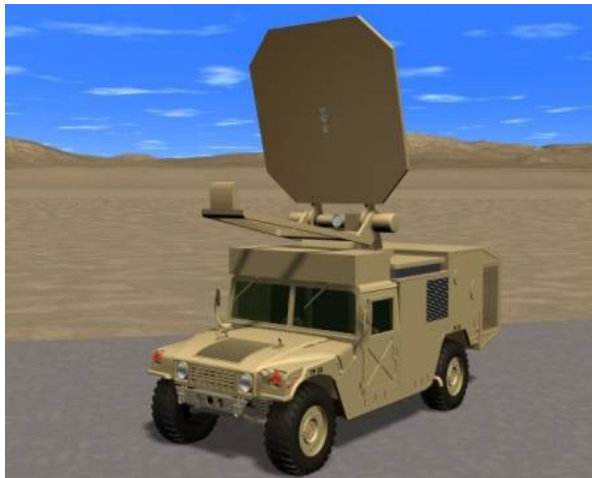
Chernobyl

Meanwhile . . .

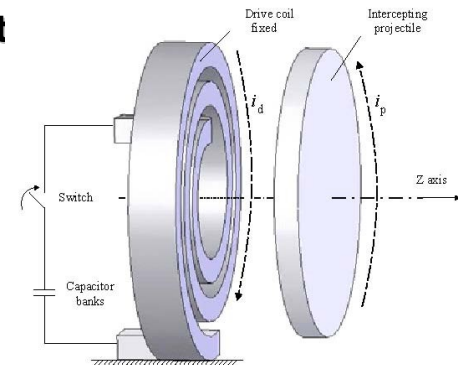
- **Worldwide nuclear power renaissance**
 - China leading; dozens of others following
 - NRC currently considering 17 license applications
- **Small reactor designs available now or near-term**
 - Japan
 - Russia
 - South Africa
 - Some US proposals
- **DOE Advanced Fuel Cycle Initiative chartered to**
 - Reduce proliferation risk
 - Reduce residual fissile/radioactive material
 - Increase useful energy content
- **Greatest uranium reserves in countries that do not sponsor terrorism**
 - Australia
 - Canada
 - Kazakhstan



Electric Weapons provide Umbrella of Force Protection- from Lethal to Non-Lethal



Electric Railgun and LASER
air and missile defense syst



Electric Active Denial System

Electric Armor
Active and passive



How will an Autonomous Brigade change the “Tooth to Tail” 2

- **Security forces diverted to secure convoys**
- **Combat activities limited by logistics capacity**
- **Support personnel required to transport, handle materials**
- **Contractor personnel and facilities required to support fuel and other logistics**



An Autonomous Electric Brigade

- **Unmatched combat power** - at all levels of conflict (counter-insurgency to heavy combat)
- **Umbrella of force protection** - capable of protecting itself and reaching throughout the entire area of operations
- **Worldwide mobility** - capable of lift by air, land or sea
- **Unprecedented sustainability** - nearly autonomous operation for extended periods of time (minimum of resupply)
- **Self-contained** - produce electricity, fuel, ammunition and water on site
- **Supports stability operations and emergency relief efforts** - provides energy and water for supporting forces and civilians

An Autonomous Electric Brigade would constitute a new, global military capability.

This concept requires technology advancement, but no “magic”



Summary

- **Hypervelocity electric railguns provide revolutionary advances in lethality, range, survivability and sustainability**
- **The operational, organizational, industrial and cultural consequences will be huge.**
- **Additional disruptive technologies to produce fuel and water on site can enable the formation of Autonomous Electric Brigades.**
- **The consequences of transforming to an Electric Army will be profound and have revolutionary impact.**

